

**A CRITICAL STUDY OF THE CONTENTS OF BSCS
(YELLOW VERSION) AND NUFFIELD MATERIALS
IN BIOLOGY AND APPLICABILITY OF
THESE TO INDIAN CONDITIONS**

BY

SHANEE T. ASHANI

ADVISORY COMMITTEE

**SRI RAJENDRA PRASAD
DR. M. LAKSHMANAN**

**SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE ASSOCIATESHIP OF THE NATIONAL
INSTITUTE OF EDUCATION
NEW DELHI - 16**

1967-68

A C K N O W L E D G E M E N T

The author expresses her deep sense of gratitude to Prof. M.C. Pant, Head of the Department of Science Education for his keen interest and encouragement.

The author is greatly indebted to Mr. R. Prasad and Dr. M. Lakshmanan for their guidance and helpful suggestions throughout the course of the present work.

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INTRODUCTION

The earliest foundations of all our natural scientific knowledge is to be sought in the observation of nature by prehistoric peoples. Early Biology was closely bound up with medicine, sorcery and religion. Much of what was learned was kept as closely guarded secrets by priests until the time of Greeks, when medicine became the province of a special group of people and natural science could flourish as an independent field of enquiry open to all who wanted to pursue it. Until the early 20th century, biologists concerned themselves mainly with morphology, taxonomy and anatomy of plants and animals. Vast amount of information was collected about habit and forms of plants and animals, their development and their relationships.

The teaching of Biology was very simple in the olden days. Teachers lectured with aid of specific objects. Very little was known about psychology or how adolescents learn. The pupil is expected to study, with the book in one hand, and the specimens in the other. Principles and foundations of education, curriculum practices and methods of teaching were confined to the three "I"'s - listening, looking and learning.

No where is change more rapid and continuing than in science and particularly advances are being made more rapidly in Biology. The Science of Biology today is not the same science of forty or fifty years ago. The progress of research in Physics and Chemistry, opened new vistas of knowledge and new techniques for investigating biological phenomena. The improved technology enabled man to investigate nature better. Today's accelerated pace of research imparts to Biology a rapidly changing character, as investigations pile one on top of another. The subject has

undergone much change in its content and character. The microscope has been followed by the ultramicroscope, electronmicroscope, spectrophotometer and all ingenious instrumentation of modern physics and chemistry. The biologist, searching into the mystery of life probes more deeply and studies smaller bits and happenings.

But teaching of Biology in secondary schools is still teaching some facts regarding different topics. The emphasis has largely been on descriptive and morphological treatment, functional aspects and on a authoritative content - facts, concepts, principles; instead of emphasis being placed on investigative processes. During teaching, the lectures are rarely followed by demonstrations. Biology syllabus comprised of bits of almost everything without any emphasis on a single theme. It provided general grounding in Biology. Most of the concepts have now become obsolete or no longer useful in present context of scientific thinking. In order to live in a scientifically based civilization with appreciation of forces that are shaping lives of modern citizens, what is needed is an understanding of what Biology really is and a variety of ways for finding out verifiable information. Thus from every point of view existing course in Biology and the method of presenting it is quite out of date and out of tune with modern needs of education.

Therefore, there is need for thorough revision in curriculum and methods of teaching. We should include new perspectives of Biology in curriculum. At the current rate

of scientific advance, there is about four times as much significant biological knowledge today as in 1930. By the end of the year 2000, there would be a hundred times as much Biology as it was in the beginning of the century. Thus we should be highly selective in our choice of what scientific facts, concepts and principles to present, so that important findings of new Biology, together with profound insights of the older Biology, may be included. A balance has to be struck between depth and breadth.

As a result of this need, a large number of programmes were undertaken all over the world to improve the content, methods and practice of Biology teaching. Two of these programmes have come out as the most outstanding and these are;

- (i) The Biological Sciences Curriculum Study,
sponsored by the American Institute of Biological
Sciences, United States of America, and
- (ii) The Nuffield Biology Project sponsored by the
Nuffield Foundation, United Kingdom.

Following this, other countries such as Japan, Colombia, Peru, Philippines and Ceylon have also organised new programmes for improvement of Biology education. These countries have produced Biology books which are adaptations of the BSCS texts. In India the NCERT has undertaken a major programme ^{II}for improvement of science education. Panel of specialists have been set up to develop curricula and to write text books, teacher's resource book and other materials on school subjects. The Biology panel under the Chairmanship of the late Prof. P. Maheshwari, has drawn up a revised curriculum and prepared a new "Textbook of

Biology for higher secondary schools". This is the first modern book on school Biology produced in India.

One of the projects of the National Council of Educational Research and Training is carried out in collaboration with the UNESCO, for improvement of science and mathematics education at middle school stage (VI, VII, VIII). Under another project five Study Groups in Biology had been set up which are functioning in the universities of Delhi, Punjab (Chandigarh), Calcutta, Osmania (Hyderabad) and Madras. The members of these Study Groups have differing backgrounds and are free to adopt the approach that they think best. They will prepare curricula and textbooks for school Biology at two levels - the first level comprising classes V, VI and VII and the second level comprising classes VIII, IX and X.

Present Problem

The BBCs and Nuffield Biology materials have aroused considerable interest in our country. Although these materials are good in their approach and have great merit, yet there are difficulties in using these materials as such and also their adaptations in our country. Hence, a critical study of these materials along with materials produced by the panel headed by Prof. P. Maheshwari in India, has been undertaken with a view to find out how these materials could be put into a curriculum which is best suited to a developing country like ours.

An analysis of this sort is also considered timely in view of the projects on improvement of science education undertaken by the National Council of Educational Research and Training at present.

For our study, we have preferred yellow version of BSCS texts because it is comparable to Indian text books in many ways. In Yellow Version, the major concepts are treated system by system as it is in our Biology books. The Yellow Version attempts to cover the major sub-fields of Biology as our traditional textbooks do. In Indian textbooks important Biological discoveries are dealt with in a historical perspective to give an idea of how Biology progresses. This is true with Yellow Version also.

This study is intended to make a critical analysis of ideas and subideas of BSCS and Nuffield Project. In this, we have tried to study the depth to which they have gone as far as content is concerned and also method of presentation and how these can be adapted or modified so that they can be usefully applied to Indian environment.

**GENERAL ANALYSIS - THEMES,
AIMS AND OBJECTIVES OF BSCS AND NUFFIELD
BIOLOGY PROJECT**

Biological Sciences Curriculum Study

The beginnings of the current curriculum reform movement in U.S.A. are commonly identified with the successful launching of first Russian satellite in the fall of 1957. This event set off blasts of charges and countercharges regarding the effectiveness of school education and also accelerated curriculum revision particularly in science.

In January 1959, the AIBS, a professional society representing 85000 biologists established the Biological sciences curriculum study as a means of contributing to the improvement of secondary school Biological education. Headquarters for the study were established in the campus of University of Colorado. The functions of BSCS were outlined as follows: "To evaluate the content of present biology course offerings, to determine what biological knowledge can and should be learned at each school level, and to recommend how this goal can best be achieved". The most significant feature in the development of the BSCS materials has been the fruitful cooperation between research biologists and high school teachers.

The work of BSCS is unique in that it has developed 3 sets of primary materials green, blue and yellow versions - each differing in approach but organized around similar unifying concepts.

Content and emphases of BSCS tests:

The biology that was in schools (in U.S.A.) in 1960 was from 20 to 100 years behind the advancing front of science. With so much of new biological data available along with older material, the main problem in improving the biological course was what to teach, how much to teach and how to teach. It

as found that conventional texts had also dealt with all important levels of biological organization, so that BSCS took the same levels of biological organization and shifted the emphasis only depending on availability of newer data.

The different levels of biological organization that are treated are as follows;

- 1 The molecular level
- 2 The cellular level
- 3 Organ and tissue
- 4 The organism as an individual
- 5 The population
- 6 The community
- 7 World Biome

A comparison of the emphasis placed on different levels of biological organization in traditional textbook and BSCS texts is presented in Fig.1.

As it is evident from the figure 1, traditional texts lay maximum emphasis on organ and tissue and to lesser extent on cell and organism; molecular and ecological levels being treated with minimum emphasis. In contrast, yellow and blue versions put maximum emphasis on cellular and molecular level respectively and are otherwise more or less comparable in the degree of emphasis, they put on rest of levels. Minimum emphasis is given to ecological aspects. Green version differs markedly from the above two, with relatively low emphasis on molecular level and very high emphasis on community.

It is claimed that shifting emphasis is a reflection of current states of science, namely that ecological study

Figure 1

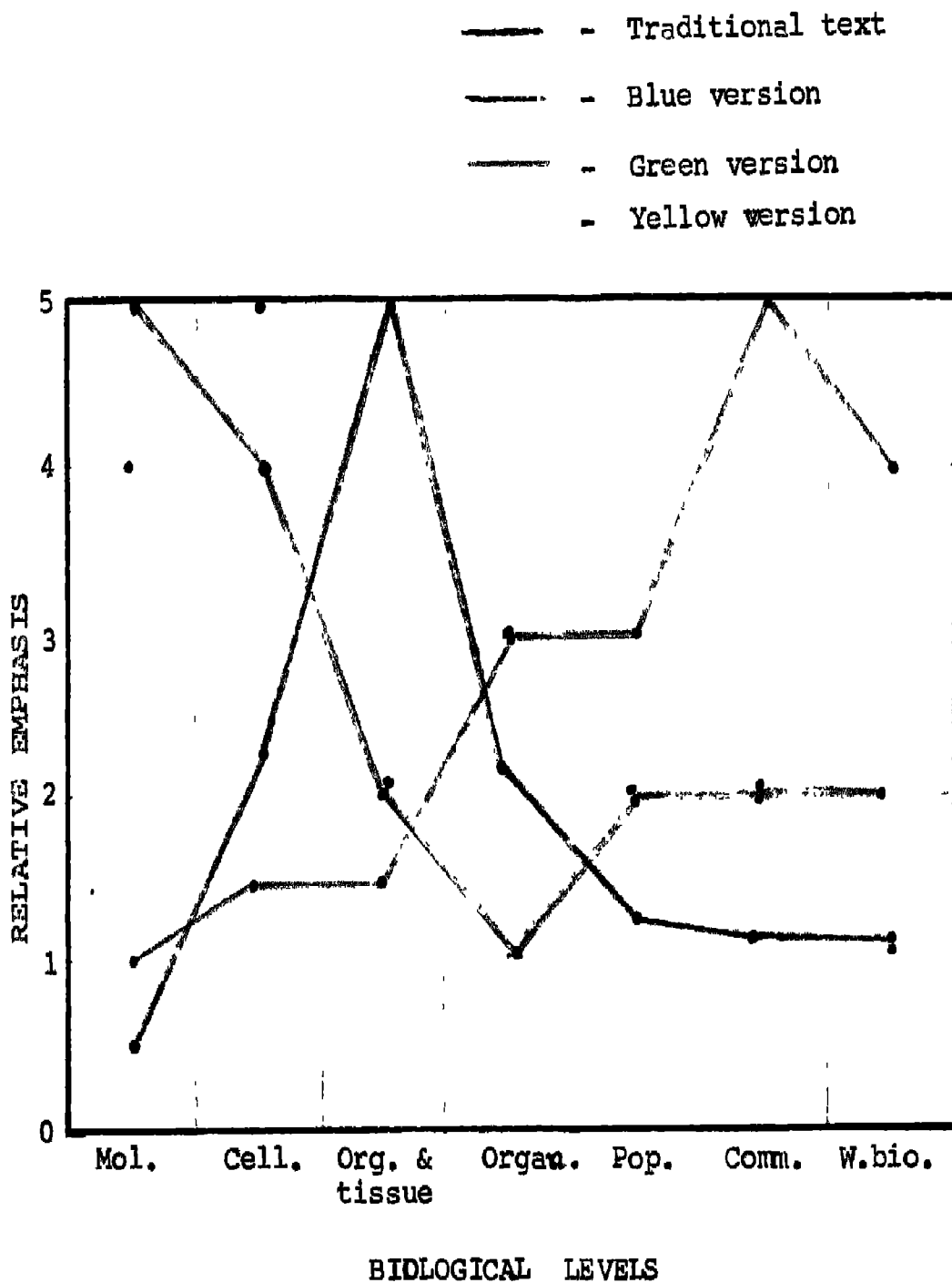


Figure 1. Showing relative emphasis placed on different biological levels by Traditional text and the three BSCS texts.

Mol., The molecular; Cell., The cellular; Org. & tissue, Organ and tissue; Organ, Organism; Pop., Population; Comm., Community; W.bio., World biome.

and molecular and cell biology have moved much ahead from where they were 40-50 years ago. It is also claimed that "where a version has chosen to put the greatest emphasis on one level it has not done so by reducing all or most of the other emphases to extremely low level". This statement is rather difficult to reconcile with, since it is obvious from the figure that some of biological levels are really at a relatively low emphasis.

Themes and objectives of BSCS material:

Though there is diversity regarding emphasis on different levels of biological organization in 3 versions, but each version is based on 9 themes. These themes are selected on basis of content and structure of modern biology and needs of students. These themes are interrelated. First 5 are concerned with content of three versions and last two with logical structure of results through which their content is conveyed. These nine themes are as follows:

1. Change of living things through time,
i.e. evolution.
2. Diversity of type and unity of pattern in living things.
3. The genetic continuity of life.
4. The complementarity of organism and environment.
5. The biological roots of behaviour.
6. The complementarity of structure and function.
7. Regulation and homeostasis; i.e. preservation of life in the face of change.
8. Science as enquiry.
9. The history of biological conceptions.

The objectives of BSCS materials are set out as follows:

1. To identify the characteristics and conceptions that provide the most comprehensive and reliable knowledge of living things as they are known to modern biology.
2. To provide that knowledge of biology and those attitudes and skills relevant to biology which will contribute mainly to students personal lives and to the execution of their responsibilities as men and citizens.

Nuffield Biology

The work of Nuffield science teaching project began early in 1962. School teachers and number of organizations in Britain had drawn attention to the need for changes in science curriculum. Grant was given by Nuffield Foundation. This project is concerned with the teaching of Biology to pupils in sixth form and in secondary schools who are studying for O-level examination. The main aim is to develop materials that will help teachers to present science in a lively, exciting and intelligible way. This was the result of collaboration of team members (teachers) consultative committees, headmasters, local authorities and Governors of schools boards.

Aims of the course:

- (1) To develop and encourage an attitude of curiosity and enquiry.
- (2) To develop and understanding of man as a living organism and his place in nature;
 - (i) Implications of Biology in relation to man's every day needs

(ii) Influence of man's activities on other organisms.

- (3) To know about variety of life and feeling for all living things.
- (4) To encourage a respect and feeling for all living things.
- (5) To teach about scientific investigations and design of experiments.
- (6) To develop a critical approach to evidence.
- (7) To show that human endeavour has contributed a lot toward the growth of Biology.

Objectives:

- 1. To teach Biology, with an emphasis on experimentation and enquiry rather than teaching facts. In other words to make pupils understand basic concepts by allowing them to face series of problems.
- 2. Work done outside school time should form a part of the course.
- 3. To encourage discussion among pupils in order to make them better understand the spirit and methods of scientific enquiry and also to provide an opportunity to consolidate their ideas.

Materials:

The Nuffield project has developed a series of pupil's texts, one for each of five years of an O-level course which are closely integrated with teacher's guides. Teacher's guides

form the back-bone of O-level publications.

The following are the titles of the five texts and teachers guides:

- Nuffield Biology Text I - Introducing living things.
 II - Life and living processes.
 III - The maintenance of life.
 IV - Living things in action.
 V - The perpetuation of life.

Nuffield Biology Teacher's guide I-V

The Programme of Biology in Indian

Higher Secondary Schools:

In other countries the status of school Biology has been steadily improving; but the Biology curricula in Indian schools have remained almost unchanged ever since they were introduced. Main shortcomings in Biology curricula are the following:-

- (1) Biology is taken as an elective subject by science students.
- (2) Main emphasis in syllabus is on structure, definitions and explanations.
- (3) Syllabus is primitive, too mechanical and dull.
- (4) Traditional division of the course into Botany and Zoology.
- (5) Curriculum represents an endless series of technical terms and biological names.
- (6) Lack of information about interdependence of plants and animals and on the role of biology in human welfare.
- (7) Morphological portion forms main part in syllabus, while physiology, ecology, cell biology, evolution, population and molecular biology are neglected.
- (8) Curriculum has excluded the study of human biology.

The above shortcomings are responsible to some extent for making biology the least popular of all sciences in India. In Delhi itself percentage of schools having physics and chemistry is 63.36 while Biology is taught in 34.5% of the schools only.

Reasons for these shortcomings in curriculum can be traced to the origin of higher secondary courses in India. In 1945, in most of the states, elective and compulsory biology courses were introduced at higher secondary stage. These Biology courses were just condensed form of intermediate biology courses. Thus all dead wood of intermediate syllabus was introduced into school syllabus.

Reading material and practical work:

No special text books are attempted for teaching of Biology in higher secondary level. The only books prescribed are those which are used in colleges and are written specially for that level. These books are loaded with many technical terms, lengthy descriptions such as descriptions of different systems of Frog, (A textbook of Zoology by Vidyarthi) and vague definitions as definition of caruncle in (A class book of Botany by Dutta). Biological information available from these textbooks is at least 50 years old. Practical work is just routine laboratory experiments with no emphasis on enquiry or investigation. Field work has no place in it. The pattern of Practical work followed by most schools is as follows;

Botany - Identification of microscopic slides and some families, description and sectioning of materials as prescribed in syllabus; demonstration of some experiments in physiology.

Zoology - Dissection of frog and memorizing technical terms of all systems in it. Identification of microscopic slides and specimens included in syllabus.

New biology programme:

A new syllabus in Biology for higher secondary stage was

drafted in 1964 by a special panel consisting of professors, readers, research scholars and secondary school teachers headed by Prof. P. Maheshwari. This syllabus has been prepared to meet the long felt need to improve the level of Biology curriculum in India. Based on this syllabus a new textbook of Biology for higher secondary school has been prepared.

The aims of this book are:-

- (1) To adopt modernized traditional course.
- (2) To make pupils acquaint themselves with a number of different kinds of organisms, their activities, habits and their tissues and organs.
- (3) To treat Biology as a whole and not as two separate disciplines of Botany and Zoology.
- (4) To use minimum number of technical terms.

The book constitutes 7 more or less independent sections.

Section I - Some basic facts about life.

- " II - The diversity of plant life.
- " III - The diversity of animal life.
- " IV - Plant and animal physiology.
- " V - Self perpetuation or reproduction.
- " VI - Evolution Heredity and adaptation.
- " VII - General.

Almost all schools under central Board of Secondary Education in Delhi and in some other States have agreed to use new curriculum and textbook as a trial. Since this is not the best curriculum efforts have to be made to get better ones. Therefore, teachers, professors and research workers have to

work in coordination to modernize the existing curriculum and methods of instruction in Biology. They also have to convince the educational authorities, for making Biology a compulsory part of General education.

Members of the UNESCO planning mission have studied the syllabus and textbook prepared by the panel headed by Prof. P. Maheshwari. With a view to rendering assistance to the panel, the members have given some suggestions for further improvement and these are as follows;

- (1) Syllabus should be prepared in more details.
- (2) First part of the syllabus should include theme about the inter-relations of animals and plants with each other and with the environment.
- (3) In studying plants and animals special attention should be given to the types which are practically important e.g. mammals, earthworms, cereals etc.
- (4) The sequence of the teaching of Zoology part can be changed; it should start with the course of Invertebrates and through Hemichordata to connect them with vertebrates. The shaping of this course should be done in phylogenetic order.
- (5) During studying the process of photosynthesis, "cosmic" role of green plants should be given more attention.
- (6) Development of animals should be properly done.
- (7) There should be one separate unit on 'Ecology'.
- (8) In syllabus the list of practicals, experimental work and list of excursions should be given.
- (9) Teacher's guide should be prepared.

CONTENT ANALYSIS OF BSCS
(YELLOW VERSION) & NUFFIELD MATERIALS

Topic: Cell

Ideas: (1) All living things are composed of cells.

Sub-ideas: (a) Structure of plant and animal cells differ.

(b) There is variation in size of cells.

(c) The shape of cells are also variable.

(d) Electron microscopic structure of cell.

BSCS	Nuffield	Comments
Animal cell is compared with plant cell; and differences and resemblances have been brought out by a diagrammatic sketch pp.57,58.	Living things are made of common units of structure called cells. Structure of plant and animal cell is described in very short without proper figures. pp.70,71 (I)	In BSCS, detailed structure of plant and animal cell, their resemblances and differences are given. Nuffield has failed to present differences and detailed structure of plant and animal cells. Historical aspect of birth of 'cell theory' is not given. Practical: Both use the observational approach for the practical.
To illustrate size of cell, various examples are given ranging from W.B.C. of man, bacteria, nerve cell to bird's egg. p.61.	Size of the cell is not mentioned.	In Nuffield subidea regarding size of cell is not brought out. This important and interesting idea should be mentioned

BSCS	Huffield	Comments
(e) This idea is brought out by presentation of figures and photomicrographs of various animal cells while discussing cells.	This is not brought out Difference in shapes of bacterial cell is only mentioned while presenting bacteria.	Practical; No experiments.
(d) It reveals:		
(i) Cell wall of fibres of cellulose.	Not discussed at all.	This important modern knowledge of cell
(ii) Cell membrane with pores.		structure is deplorably omitted from Huffield texts.
(iii) Endoplasmic reticulum in form of tubes, coated with ribosomes, present throughout the cytoplasm. pp.123,126.		Practical; No experiments.
<u>Ideas:</u> (2) Many activities go on ⁱⁿ the cells.		
<u>Subideas:</u> (a) Mostly controlled by enzymes.		
(b) Coenzymes are essential to chemical reactions controlled by enzyme and not used up in the reaction.		
(c) Energy for the cell comes from glucose.		
(a) (i) Several kinds of enzymes in each cell.	(i) Enzymes bring about chemical changes of many kinds. p .100	In BSCS - information is available in one place; most of properties of enzymes are
(ii) Enzymes are proteins.	(ii) This subidea is presented at one place and is not	discussed in general. In Huffield it is not
(iii) Enzymes can be purified.	(iii) This subidea is presented at one place and is not	discussed in general
(iv) Enzyme action is controlled by heat, PH,		

BSCS	Nuffield	Comments
amount of enzyme and temperature. pp.119-122.	discussed in detail in general.	but with reference to particular enzymes. Practical; In BSCS enzymes experiments include demonstration. In Nuffield - properties of enzymes, mostly investigatory type along with some demonstrations. are given.
P.122.	This idea is not brought out.	This is important aspect of enzyme reaction which has been mentioned in BSCS where as in Nuffield it has not been mentioned at all.
(i) From ATP energy is used up for breaking glucose.	Under "Respiration" there is very little discussion about energy their own way.	Both texts have brought out general idea in
(ii) Energy released by reaction can make 4 molecules of ATP, thus net result is 2 ATP molecules.	release.	
(iii) Electron transport chain is discussed briefly. pp.129-134.		

Ideas: (3) For genetic continuity, division or reproduction of cells.

subideas: (a) Cell grows large and divides into two; many changes take place in nucleus.

(b) Two types of cell division;

(1) Mitosis

(ii) Meiosis is a reduction division by which gametes are formed.

BSCS	Nuffield	Comments
(i) Cell grows in size	(i) Except gametes all cells are produced by mitosis.	In BSCS process of mitosis is given in detail, but name of different stages are not given.
(ii) Chromosomes appear inside the nucleus	(ii) Original cell (2n diploid)	In Nuffield, name of different stages are given but details are not given.
(iii) Nucleus divides into two and ultimately two cells are formed.	2n-diploid daughter cells (2n diploid) p.48(II) teachers guide.	
(i) Chromosome make replica, then each goes to daughter cell		Practical: BSCS has followed observational approach where as Nuffield has followed both investigatory and observational approach
(ii) Replication of DNA is also given. pp.141-146.		
(iii) In animals, same as in plants except no new cell wall forms across middle of spindle.		

BSCS	Nuffield	Comments
b)(ii)		
(i) It occurs before gametes are formed.	(i) Meiosis is a process by which gametes are formed.	In both same ideas are presented.
(ii) Two divisions results in formation of 4 cells.	(ii) Number of chromosomes halved the original number.	In Nuffield exchange and recombination of chromatin material is not mentioned
(iii) Gametes with half number of chromosomes.	original cell 4 haploid gametic cell (2n diploid) (n, haploid)	which is very important point.
(iv) There is exchange and recombination of parts of chromatids during meiosis. pp. 529, 530.		Practical: In BSCS, no experiment. In Nuffield, investigation.

Topic: Microbes

Subtopic: Viruses

Ideas: (1) Viruses are smallest living things.

Subideas: (a) Virus is a latin word meaning poison.

(b) Shape and size is variable.

(c) Structure of plant and animal virus differ in some points.

(d) Viruses reproduce inside a host cell.

(e) Viruses have characters of living things.

BSCS	Nuffield	Comments
Historical descriptions regarding discovery of viruses. pp.181,182.	Historical description is not brought out.	In BSCS - Approach is historical, and shape, size are described in details, whereas Nuffield has not described these.
.) Red shape, rounded, tadpole - illustrating some examples.	This subidea is not brought out.	
) Variation in size from 18 mμ to 450 mμ, showing examples. pp.185,186.		
Most plant virus = RNA + Protein coat.	Some virus particles consist of small number	In BSCS - reproduction is dealt to great depth and all changes in virus and host are given. In Nuffield such ideas are not dealt with which is a notable omission
Most animal virus=DNA+ Protein coat.	of complex single compounds. p.57 (II)	
(1)Details of reproduction of bacteriophage inside bacterial cell is given.	Existence of viruses can destroy bacteriophage. p.27(II).	

BSCS	Nuffield	Comments
<p>(ii) As virus enter in the host cell, it changes the activities of cell to need of its own. pp.186,187.</p>	Not dealt	<p>Nuffield has failed to bring out discussion on the peculiar position occupied by viruses. Experiments are not given in both.</p>
<p>(i) Viruses undergo mutations.</p>	Not dealt	
<p>(ii) Viruses show genetic recombination.</p>	Not dealt	
<p>(iii) Viruses show DNA replication.</p>	Not dealt	

Topic: Microbes

Subtopic: Bacteria.

Ideas: (2) Bacteria are very small micro-organisms.

Subideas: (a) The discovery.

(b) Size and shape of bacteria is variable.

(c) Cell of bacteria consists of different parts.

(d) Bacteria require a variety of substances for their growth.

(e) A sexual reproduction takes place by means of cell division.

(f) Sexual reproduction takes place between two strains of bacteria.

BSCS	Huffield	Comments
1. History of discovery of bacteria is brought out.	History of discovery of bacteris is brought out. p.10(II).	In both same treatment.
(i) Size is variable from 0.2 μ in width and from 2 μ to 10 μ in length.	(i) Bacteria vary in size from 2 μ to 2 μ and average is about 1 μ . P.10 (II).	Practical; In BSCS, investigation on characters of bacteria and effects of antibiotics on different bacteria.
(ii) Different forms (cocci, bacilli, spirilla) and their arrangement is given.	(ii) Each form with its size and arrangement is given. pp.10,11(II)	In Huffield, microbiological techniques are taught to pupils.
2. Detailed structure of cell-with cell wall, cytoplasmic membrane, nucleus, nucleoids,	It is not dealt at all.	No experiments.

BSCS	Nuffield	Comments
vacuole and DAN bodies is mentioned.		
(ii)Detail structure of cell wall is given. Mostly heterophyte, some are saprophytes and some are autotrophs. pp.108-201.	Bacteria require beef extract bacto peptone and bactoagar to grow. P.19(II). (ii) Idea of autotroph or heterotrophs is not mentioned.	Nutrient required by bacteria for growth are mentioned in both. But idea of autotrophs or heterotrophs is not brought out in Nuffield.
In favourable conditions cell-division takes place.	When right food is given multiplication of bacteria takes place. P.27(II).	In BSCS - details of cell division are presented Whereas in Nuffield details are not given.
(i) Historical description regarding discovery of sexual reproduction in bacteria is given.	There is no mention about sexual repro- duction in bacteria.	Sexual reproduction is quite an interesting and important aspect of bacterial life. This is again a notable omission in the Nuffield biology. No experiments in both.
(ii)Details and advantages of sexual reproduction are also brought out. pp.201-206.		

Topic: Microbes

Subtopic: Bacteria and Health

Concept: Bacteria play very important role in human life.

Subconcept: (a) Some bacteria are harmful for human health.

(b) Many bacteria are useful and essential to many processes going on in the life.

BSCS	Nuffield	Comments
Pathogenic effects of bacteria are discussed in details. pp.113,181, 197,200,210-13,221.	(i) Bacteria pollute the water, air and food. Methods are discussed by which pollution can be reduced to minimum. (ii) Disinfectants ^t are used which kill bacteria. What strength of disinfectant is used and how it is used in practice is discussed. pp.31-37 (II)	In both same ideas have been brought out. Practical: In Nuffield to study the effect of disinfectants on bacteria.
(i) Nitrifying bacteria and nitrogen fixing bacteria are important for life. p.168.	(i) Bacteria used in fixing nitrogen, p.159 (V) T.G.	In BSCS - to study effects of various antibiotics upon different bacteria.
(ii) Bacteria are useful in some ways in digestive system. p.192.	(ii) Bacteria and food. p.30 II T.G.	Demonstration.

BSCS	Nuffield	Comments
(iii) Role of bacteria as decomposers is discussed in detail. pp.161-165.	(iii) Bacteria as decomposers are discussed. p.75(III) T.G.	
(iv) Many antibiotics are derived from bacteria. p.218.	(iv) Antibiotics obtained from bacteria are discussed.	
(v) Bacteria are useful in industries. pp.224-226.	pp.41(II),66,94(V) T.G.	

Topic: Plants

Subtopic: Diversity among plants

Ideas: (1) There are diverse form of plants, all of which from plant kingdom.

Subideas: (a) Plants which have no flowers are cryptogams.

(b) Plants with flowers are called phanerogams.

BSCS	Nuffield	Comments
(i) Thallophytes includes Algae and Fungi. Some adaptive characters exhibited by mosses and liverworts are discussed in details. Life cycle of a mass is dealt. pp.261-268.	Main groups of plants with their special features has been discussed properly. p.3(I) Table 5.	In both projects, classification of plants is given but in BSCS features of main groups are not discussed. In Nuffield classification is discussed in proper way based on characteristics, but evolution of sexual reproduction, economic importance of Algae, Algae and space travel are not discussed. Practical: In BSCS, to get knowledge about variety of plants and their features. In Nuffield sorting living things into groups and demonstrations.
(ii) Evolution of sexual reproduction in Algae, Algae and world today and economic importance of Algae is discussed. pp.250-258.		
(iii) Characters of vascular land plants are discussed. History and features of primitive vascular land plant <u>Rhynia</u> is discussed. pp.268,269.		

BSCS	Nuffield	Comments
(v)How the primitive type of vascular plant provides starting point for consideration of the evolution of leaf, root, arrangement of supporting and conducting tissues and protected sporangia is discussed in details. pp.270-273.	This idea is not dealt at all.	In BSCS - evolution of different parts of plants as indicated by primitive land plant is discussed but in Nuffield it is not so.
(i)Plants with naked seeds i.e. Gymnosperm not discussed.	(i)Gymnosperms discussed under classification.	
(ii)Important evolutionary steps in production of the seed are described. p.275.	(ii)Important evolutionary steps in production of seed are not discussed.	In BSCS, the evolution of ^{and} pollen tube, seed and the female gametophyte are discussed whereas in Nuffield it is just descriptive like traditional books.
(iii)Plants in which seeds are enclosed inside ovary i.e. Angiosperms are discussed briefly.	(iii)Different parts of flower, different kinds of pollen grains, insects and flowers are discussed. pp.117, 118,120,121(ii)	In BSCS, more emphasis is laid on evolutionary steps leading to the modern land plant.
(iv)With reference to following points a vehicle for sperms, the importance of flowers, the protection of seed, and the land gametophyte. pp.275-279.		Practical; In BSCS, only observations. In Nuffield, observation, experimentation and demonstrations.

BSCS	Nuffield	Comments
(iv) Under the importance of flowers pollination is discussed. pp. 276-277.	(iv) Formation of pollen grains, ovules, fertilization is discussed. pp. 133, 141 (II).	Pollination and fruit development are discussed in both emphasising the same points. In BSCS,
(v) Formation and development of fruit is discussed. p. 277.	(v) Pollination and ways in which flowers ensure cross pollination is described. pp. 134, 135, 137 (II).	ways in which flowers ensure cross pollination is not discussed. Practical; In BSCS no experiment. In Nuffield - Investigation
	(vi) Formation and development of fruit is discussed. p. 138 (II).	

Topic: Plant

Subtopic: Mushrooms & Yeast

Ideas: Fungi are plants which do not have chlorophyll.

Subideas: (a) Slime moulds show characters of plant and animal.

(b) A true fungus is always composed of hyphae.

(c) True fungus has some adaptations to land environment.

(d) Fungi are useful to human beings in some ways.

(e) Some fungi have harmful effects.

(f) Yeasts are different from true-fungi in some characters and are very useful.

BSCS	Huffield	Comments
(a) Fruiting body and spores of slime moulds resemble plants.	This is not mentioned. Fungi are not true plants. p.23(1)	In BSCS, Slime moulds, mushrooms are discussed in general and in brief.
(b) Plasmodium stage resembles animal. p.232.		Rhizopus is illustrated as an example to show structure of hyphae, and reproductive parts.
Structure of hyphae has been discussed by referring Rhizopus as an example. p.232.	Colonization of <u>penicillium</u> <u>Aspergillus</u> and <u>mucor</u> is discussed in connection with competition between non-green plants. p.12(rv).	Adaptations of fungus are dealt nicely. In Huffield, "Fungi" as a separate topic is not dealt. Some names and descriptions are given in connection with "Against disease", microbes etc.

BSCS	NUFFIELD	COMMENTS
(i) Adaptations of fungi are discussed with reference to (i) large number of spores (ii) Zygote, which has got thick resistant wall.	Structure of penicillium is discussed in very brief. p.50(II) Adaptations ^{at} are not discussed.	In Nuffield adaptations of fungi are not discussed which should have been mentioned.
(i) Fungi used for eating are discussed.	Penicillin as an antibiotic is discussed. p.49(II).	Practical; In Nuffield, practical work and demonstration. In BSCS, microbiological techniques and demonstrations.
(ii) How antibiotic are produced by fungi e.g. <u>penicillium</u> and used by man, is discussed. pp.220,221,235.	Role of fungi in succession, symbiotic role with pleurococcoid algae is discussed. P.234(IV), P.175(III)	
(i) Spoilage and decay of various living and non-living things by fungi are discussed.		In BSCS, uses and harmfulness of fungi are discussed. In Nuffield, only uses are discussed.
(ii) Diseases of human beings caused by fungi are discussed. P.236.		Yeast is dealt in nice way in both except that in Nuffield details of sexual reproduction are not given.
(i) Yeast do not form hyphae. (ii) They reproduce by budding. (iii) They reproduce asexually by budding.	(i) They reproduce by budding (ii) Yeasts can be haploid or diploid. P.51(V)	Practical; In BSCS, to compare fermentation of different sugars by yeast.

BSCS	Nuffield	Comments
i) There are different strains of yeast.	(iii) Sexual reproduction takes place in yeast	Practical! In BSCS, To study anaerobic metabolism.
(v) Sexual reproduction is known in yeast.	(2 strains) P. 83(V)	
ii) Use of yeast are discussed in details. P. 239.	(iv) Life-cycle of yeast is discussed.	In Nuffield, to study effect of heating on sugar making and
	(v) Uses of yeast are discussed in details. pp. 140(IV), 42(III), 89(V).	to make wine and bread.
	(vi) Mutation in yeast is dealt in brief. P. 57(V).	

Topic: Plant

Subtopic: Stem

Ideas: (1) A bud is condensed shoot of a plant.

Subideas: (a) Vegetative buds develop into stem and leaves.
They occur at the tips of branches and in axils of leaves.

(b) Flower buds are those that give rise to flowers.

BSCS	Huffield	Comments
Not dealt.	Not dealt.	In BSCS and Huffield, there is no mention regarding vegetative and reproductive buds.
<u>Ideas:</u>	(2) The stems of plants vary in texture, size form, structure and rate of growth.	
<u>Subideas:</u>	(a) Stem of plants are either soft or woody. (b) The growing rate of the stem might differ in different plants. (c) The stem is made up of different types of tissues which again vary in different plants.	
(i) When stem is soft, it is known as herbaceous plant.	This idea is not at all mentioned.	Form, texture, structure of stem is described in brief in BSCS, whereas in Huffield this idea is not at all brought out. In both,
(ii) When stem is hard, they are woody plants.		

BSCS	Nuffield	Comments
<p>1) The form of tree is mainly due to form and structure of stem. P.302.</p> <p>2) Some plants are quick growing.</p> <p>3) Some plants are slow growing.</p> <p>Anatomy of a dicot stem, differences from monocot, are dealt.</p> <p><u>Ideas:</u> (3) There is growth in thickness of stem.</p> <p><u>Subideas:</u> (a) Growth in thickness takes place through the activity of cambium.</p>	<p>It is not dealt.</p>	<p>modifications of stem which are useful to man are not discussed.</p>
<p>1) Cambium cells undergo division and form cambium ring.</p> <p>2) Cambium ring cuts secondary xylem on outer side and secondary phloem on inner side. P.304.</p> <p>3) The rate of increase in thickness varies according to season. P.306.</p>	<p>It is not at all mentioned.</p>	<p>In BSCS, Secondary growth of stem is given in brief but in Nuffield, this idea is not brought out.</p>

Ideas: (4) Water, minerals and food materials are transported through stem.

Subideas: (a) Xylem is responsible for upward movement of materials.

(b) Phloem is responsible for downward movement of materials.

BSCS	Nuffield	Comments
(1) Xylem is made up of Tracheids or vessels and other tissues.	Through xylem vessels water travels up the stem to leaves.	In both, same ideas have been brought out except that in Nuffield tracing of radioactive sucrose containing C_{14} is described.
1) Water and mineral materials absorbed by roots are conducted through xylem tissues to the leaves. pp.304, 305.	P.131(III)	
(1) Phloem consists of sieve tube, phloem parenchyma etc.	(1) Organic substances manufactured in leaves are transported to different parts through phloem tissues.	Practical: In BSCS, studying structure of stem with regard to its function.
1) Organic food substances manufactured in leaves reach different parts through phloem tissues.		In Nuffield, investigation with reference to upward flow in stem.

Topic: Plants

Subtopic: Roots

Ideas: Root is the part of plant which develops from radicle and grows away from the light in the soil.

Subideas: (a) Root systems of plants are mainly of two types.
 (b) Adventitious roots develop from different parts of plants (except radicle) and have different functions.
 (c) There are different regions in a root.
 (d) Root is made up of different kinds of tissues.
 (e) Structure of root is adapted to its many functions.

BSCS	Nuffield	Comments
1) Fibrous root system which is typical of monocots.	It is not dealt.	In BSCS, types of root are mentioned except adventitious roots, which are also important.
1) Tap root system which is characteristic of dicots. P.308. Not at all mentioned. Different regions of root are described by well labelled diagram. Fig.-16.8. P.310. TS. of roots has epidermis, cortex and vascular tissues.	(1) This idea has been brought out. (ii) Division of the cells of root tip in Bean and how to measure root growth is discussed. pp.70(I), 48(V). Practical	In BSCS, different regions structure and functions of root are dealt in proper way. But in Nuffield structure and function of roots is not dealt. BSCS, experiment to study root in connection

BSCS	Huffield	Comments
(i) Root absorbs water and mineral salts from soil.	(i) Root absorbs water (ii) Root ^a hairs are water absorbing region of the root. P.198(III).	with its functions.
(ii) Conduction of absorbed material.		
(iii) Support.		
(iv) Storage. P.310.		

Topic: Plant

Subtopic: Photosynthesis

Ideas: (1) Green plants in the presence of light and CO_2 manufacture carbohydrates. This process is called photosynthesis.

Subideas: (a) Green leaves of plants are main organs of photosynthesis.
 (b) Light is necessary for the manufacture of food in leaves.
 (c) CO_2 is necessary for manufacture of glucose in plants.
 (d) Oxygen is produced during photosynthesis.
 (e) Most of photosynthesis is carried out in seas.

BSCS	Nuffield	Comments
(i) In leaf chlorophyll is located in chloroplasts.	(i) Structure of green leaf is dealt in detail. P.138(III).	Approach is the same in both projects. In both whole process and all events of photosynthesis are discussed in details using some chemistry.
(ii) Mature chloroplast contains many grana.	(ii) Chloroplasts are disc like bodies containing	In Nuffield, amount of photosynthesis occurring in seas is very important and interesting point and is not mentioned. Photosynthesis and respiration as two opposite processes are discussed in Nuffield.
(iii) Each granum is made up of lamellae which ultimately consists of protein, fatty substances, chlorophyll and other pigments.	chlorophyll.	
(iv) Chlorophyll a, b, xanthophyll and carotene are present in leaf P. 200.		

BSCS	Nuffield	Comments
<p>(1) Light energy absorbed in the regions of violet, blue, orange and red wavelengths/synthesis- ing energy rich compounds. P.288.</p> <p>(1) Light energy absorbed by chlorophyll is used to change ADP to ATP and to split water.</p> <p>High energy hydrogen compounds react with CO_2 and ultimately glucose, is formed.</p> <p>(1) Water molecule is broken down and oxygen is released.</p> <p>(1) This is confirmed by using heavy oxygen.</p> <p>(1) 90% of total photosynthesis is carried out by aquatic algae in seas.</p> <p>(1) Mainly red algae. P.297.</p>	<p>(1) Chlorophyll mainly absorbs blue and red light.</p> <p>(1) Energy is used to split water molecules. P.138(III).</p> <p>Hydrogen reduces CO_2 to sugars and other organic compounds. pp.142-150(III).</p> <p>Oxygen is released by splitting of water molecule. P.145(III).</p> <p>It is not dealt.</p>	<p>Practical; In BSCS, experiment to determine that presence of chlorophyll in the leaves is necessary for photosynthesis.</p> <p>In Nuffield, observations, tests for starch.</p> <p>Experiment includes tracing of radioactive carbon atoms in sugar formation.</p>

Topic: Plant

Subtopic: ⁿ
Response

Ideas: Plants respond to their environment.

Subideas: (a) Tropism is a response that plant makes to a stimulus.

(b) There is some mechanism by which plant responds.

There are a number of compounds which bring about plant growth.

BSCS	Nuffield	Comments
(i) Response of plant towards gravity is geotropism.	Seedlings respond to the stimuli of light and gravity. P.196(IV).	In BSCS, the idea of tropism, phototropism and geotropism are described in detail,
(ii) Negative geotropism of stem and positive geotropism of roots have been discussed.		whereas in Nuffield the idea of response in plants is ^{just} mentioned and not discussed in detail.
(iii) Response of plant towards light is phototropism.		
(iv) Phototropism of shoot and root is discussed. P.330.		
b. Experiments of Jensen, Darwin and Went are given with their conclusions. P.330.	Experiments of Boysen-Jensen and Went, with their results are discussed. pp.197-199 (V)	Historical discovery of plant growth regulators is dealt in both.

BSCS	Nuffield	Comments
<p>i.(1) IAA regulates elongation of cells.</p>	<p>IAA is effective in very small concentrations for growth.</p>	<p>In BSCS, NAA and 2,4-D are also mentioned. How</p>
<p>(ii) How IAA effects growth has been discussed in details. This point is not</p>	<p>P.197(IV).</p>	<p>IAA promotes growth is discussed in contents interesting way in BSCS.</p>
<p>(iii) Other compounds such as NAA and 2,4-D which also promote growth of plants are discussed.</p>	<p>dealt.</p>	<p>In Nuffield, this point is not discussed. § Practical; BSCS deals with observations of growth in plants and studying the effect of auxins on growth of plants. In Nuffield, experiments are organised to study and observe the effect of IAA on young shoot.</p>

Topic Food

Idea: Food is necessary as fuel in respiration for maintenance and growth.

Subidea: (a) Food stuffs can be grouped according to their chemical constitution.

(b) They can be detected in food by chemical tests.

(c) Material and energy of food stuffs forms cycle along food webs.

BSCB	Nuffield	Comments
<p>(1) Food stuffs of various types are discussed under the chapter of digestion and note separately. Pp. 387, 393. Their chemical tests are also given in laboratory guide.</p>	<p>Main classes of foods e.g. carbohydrates, fats, proteins, salts, vitamin are described and it is mentioned that they differ chemically from one another.</p> <p>Chemical tests of food stuffs is given.</p> <p>Materials and energy contained in food stuffs flow along food webs from producer to consumers to decomposers. Pp. 52-54(III).</p>	<p>In BSCB, classes of food are discussed in laboratory guide, and not as a separate chapter in text.</p> <p>In Nuffield, discussed in detail.</p> <p>Practical; In BSCB, to test food stuffs. In Nuffield, testing food for different stuffs. Use of food calorimeter to estimate calorific value of food.</p> <p>Demonstration.</p>

Topic: Animal

Subtopic: Digestion

Idea: Large food molecules are broken into smaller ones by process of digestion.

Subideas: (a) Digestion is controlled by enzymes.

(b) Different animals have different processes of digestion.

BSCS	Nuffield	Comments
The forces of break down of large molecules into smaller ones is controlled by enzymes.	(i) Large molecules of food are broken down by heating with dilute acids. (ii) Chemical processes of digestion are controlled by enzymes. pp. 97, 100 (III).	In both, same points have been brought out.
(i) Unicellular organisms such as <u>paramecium</u> have intercellular digestion. pp. 347-348.		In BSCS, digestive system of different types of organism is dealt but more emphasis is given on human digestive system. In
(i) In multicellular organisms, digestion is extracellular and the process is carried out in a canal or tube.		Nuffield, digestive system in general and human digestive system ^{details} in particular is described.

BSCS	Nuffield	Comments
<p>1) Digestive system is discussed with reference to <u>Hydra</u>, <u>Earthworm</u>, and man. pp.385-392.</p> <p>In man - digestive canal and functions of various parts of it are mentioned.</p>	<p>Digestive system of man is dealt in details with reference to parts of canal, enzymes at work and process of absorption. pp.94-97(III).</p>	<p>Practical; In BSCS observing digestion in <u>paramecium</u>. In Nuffield, investigation and demonstrations.</p>

Subtopic: Transportation

Ideas: Digested food molecules reach different parts of body through process of transportation.

- Subideas: (a) In small organisms food is transported by diffusion.
 (b) Organisms of greater size and complexity have blood system.
 (c) Some organisms have lymphatic system.

BSCS	Nuffield	Comments
Transporting system in small organisms is discussed by using description and using diagrams, pp. 398-399.	Transporting system is discussed in general. p. 112(IV).	In BSCS, idea is given with reference to different organisms. Whereas in Nuffield idea is dealt in general.
(i) Details of blood vascular system has been brought out in different organisms such as <u>Hydra</u> , <u>Planaria</u> , <u>Earth worm</u> and <u>Grass-hopper</u> .	Insects have no capillaries and haemoglobin is also absent. p. 113(IV).	In both, blood vascular system of man is discussed in details, by giving diagrams and figures also. In Nuffield - mechanism of heart attack which is an interesting aspect is not discussed.
(ii) Blood vascular system of man is of the closed type. Heart, arteries, veins and blood capillaries constitute the blood vascular system.	Blood vascular system of man is discussed in detail. pp. 114-120 (IV).	

BSCS	Nuffield	Comments
<p>(1) Mechanism of heart attack is discussed. pp.402-407.</p>	<p>There are four blood groups A,B,AB and O. p.4(V).</p>	<p>Practical: It is observational in both. In Nuffield, some investigations.</p>
<p>(1) Lymph is blood which comes out of capillary walls and enters the spaces between cells.</p>	<p>This idea is not brought out at all.</p>	<p>Idea of lymphatic system is mentioned in BSCS but in Nuffield it is not at all dealt with.</p>
<p>(1) Lymph vessels, lymph nodes constitute the lymphatic system. Lymphatic system of man is discussed. p.408.</p>		

Subtopic: Respiration

Idea: Respiration is a process in which O_2 and CO_2 are exchanged with release of energy.

Subidea: (a) Different organisms have different processes of exchange of these gases.

 (b) Different organisms have different organs for respiration.

BSCS	Nuffield	Comments
1) In smaller organism it takes place through process of diffusion.	Exchange of gases in smaller organisms is not dealt.	In BSCS exchange of gases is discussed in smaller and larger animals including man.
2) In organisms of greater size and complexity, and exchange of gases takes place by help of circulatory system.	Respiration of higher animals is described in general.	But Nuffield has described this idea in general and laid more emphasis on the exchange of gases in man.
3) In higher animals haemoglobin plays an important role in this process.	In higher animals haemoglobin plays an important role in the process of respiration.	
4) Lower organisms use moist, skin, gills or tracheal tubes for respiration. pp. 413-414.		In BSCS, respiratory organs of different organisms is brought out in short and more emphasis ^{is} to laid on human respiration.

BSCS	Nuffield	Comments
(i)Lungs as respiratory organs in higher animals including man are discussed. pp.414-419.	(i)Lungs as respiratory organs in man are discussed. pp.5,26, 27(III).	In Nuffield, only human respiration is discussed but with interesting side lights.
	(ii)Mechanism of lung ventilation is mentioned. p.17(III).	Practical: In BSCS, determination and comparison of CO_2 produced in human bodies.
	(iii)Working of an "Iron lung" is discussed. p.20 (III).	In Nuffield, determination of heat produced in human bodies.
	(iv)Artificial respiration is mentioned.	
	(v) Relationship of physical education and gas exchange is brought out.	

Subtopic: Excretion

Idea: The removal of the waste products of metabolism is known as excretion.

Subidea: Different organisms have different organs and ways for removing waste products.

BSCS	Nuffield	Comments
<p>In small organisms (paramecium and Hydra) it is through diffusion. p.421.</p> <p>In planaria system of tubes (flame cells in end) does the excretory function. p.422.</p> <p>In Earthworm, nephridia are excretory organs and are found in various parts of body. p.422.</p> <p>Malpighian tubules are excretory organs in arthropods. p.423.</p> <p>Excretory organs and process of excretion in man are dealt in detail. p.424-428.</p>	<p>Not dealt.</p> <p>Excretory organs, their functions and process of excretion in man are dealt in great detail. pp.219-221. Kidney as an organ of adjustment is discussed. p.221(V).</p>	<p>In BSCS, excretory system in different organisms is dealt mainly using diagrams, whereas in Nuffield only excretory system of man is dealt with.</p> <p>Practical: In BSCS, investigations.</p> <p>In Nuffield, no experiment.</p> <p>In both almost the same details of human excretion are given except that in Nuffield more emphasis is laid on the homeostatic aspect of kidney. Kidney is dealt as an important organ.</p> <p>Practical: In BSCS, No experiment. In Nuffield, observations and demonstrations.</p>

Subtopic: Coordination

Idea: Multicellular organisms have special means of coordinating the activities of cells.

Incidence: (a) Coordination is brought about partly by nervous system.

(b) Coordination is brought out partly by endocrine system.

BSCS	Huffield	Comments
1) In lower animals nervous system constitutes the net of threads and extends throughout the animal. P.437.	(i) It is not dealt but history of nervous system is discussed. P.186(IV).	In BSCS, nervous system of different animals is given in brief and that of man, in detail.
1) Evolutionary development of central nervous system. P.438.	(ii) There are three different types of neurons based on their functions. (i) Afferent (sensory) (ii) Efferent (motor) (iii) Association neurons. P.187(IV).	In Huffield, general description of nervous system and history of nervous system are mentioned.
1) Central nervous system contains neurons which transfer impulses from receptor cells to motor neurons which lead to muscles.	(iii) In man - brain, spinal cord, and nerves are discussed under nervous system. P.191(IV).	Nervous system of man also is dealt in detail. Practical; In BSCS, observations in Huffield-observations and demonstration.
1) In man - brain, spinal cord and network of nerves are discussed under nervous system. P.438.	Receptors, tension of relay muscles and seaf are discussed. P.191(IV).	Same ideas have been brought out in both projects. Presentation and approach are almost the same in both.

BSCS	Huffield	Comments
Receptors, effectors, sensory and motor neurons are also discussed in detail.		Practical; In BSCS, to detect the effect of reproductive hormones on organism. In Huffield, experiment is a long-term investigation.
(i)Endocrine system functions by secreting hormones.	(i)Non nervous coordination by means of hormones is discussed.	
Hormones are produced at one place and are used at another place. P.444.	(ii)Hormones are substances produced at one place affective and/at another place. P.195(IV).	
(iii)Hormones are generally distributed through the blood.	(iii)Hormones travel in blood.	
Two types of hormones sympathetic - speeds up action parasympathetic glands. slows it down.	(iv)It is not mentioned.	
	(v)Glands secreting hormones are ductless	
Endocrine glands of man are discussed in details. Their position and how they function is also dealt. P.445.	(vi)Endocrine glands of man are discussed in detail. Pp.196,197(IV)	

Subtopic: Support and Locomotion

Idea: Locomotion is a process by which animal can move from one place to another.

subidea: Locomotion is accomplished in a variety of ways.

BSCS	Nuffield	Comments
<p>Unicellular organisms use cilia, pseudopodia or flagella for locomotion.</p> <p>)Multicellular animals have different organs, which are the result of evolution. Locomotory organs in many multicellular animals including man are described. P.452.</p> <p>Among more complex animals, body movement involves supporting structures for body which may be exoskeleton or endoskeleton. P.453.</p> <p>)Evolutionary development of endoskeleton. P.453.</p>	<p>Not dealt.</p> <p>In vertebrates-muscles are used to move bones. Muscles are arranged in opposing pairs. Work done by muscle depends on length. Pp.98-103(II).</p>	<p>In BSCS, locomotory organs of different animals are described, In Nuffield, less emphasis is given to organs but more emphasis is laid on and how locomotory organs function. The description on how muscles work is very interesting.</p> <p>In Nuffield, exoskeleton and endoskeleton which with reference to evolution are not dealt. Practical: In BSCS, to investigate methods and patterns of movement in animal. In Nuffield - investigation and demonstrations.</p>

Subtopic: Reproduction

Ideas: New individuals are produced from older ones by means of reproduction.

Subideas: (a) Production and union ^{of egg & sperm} is sexual reproduction.
 (b) Method which does not involve fusion of the nuclei of two cells and meiosis is asexual reproduction.

BSCS	Nuffield	Comments
1) Sexual reproduction involves fusion of nuclei from different sources.	Same ideas have been dealt.	In both projects same ideas have been dealt with.
1) Fertilization may be internal or external. Before fertilization meiosis occurs.		Practical; In BSCS and Nuffield observations of different stages of reproduction in some animals.
1) Sexual reproduction ensures a variety of genetic types in the population.		In BSCS and Nuffield modes of asexual reproduction are dealt with, use of illustrating examples and figures.
1) Sexual reproduction takes place in all multicellular animals. It is described in a number of organisms. Pp. 426, 428, 470-480.		

BSOS	Nuffield	Comments
A sexual reproduction take place by mitosis, by fission or by budding. Pp.27,463.	(i) Asexual reproduction is very rare. (ii) New individual is exactly like parent. (iii) Asexual reproduction in <u>Hydro and star fish</u> is discussed. Pp.136-138(I).	

Topic: Genetic continuitySubtopic: Heredity

Ideas: Chemical instructions received from parents and transmitted by the reproductive cells are Heredity characters.

- Subideas:
- (a) Characters of living organism depend on interaction of heredity ^{and} environment.
 - (b) There are some laws of inheritance.
 - (c) There are similarities between behaviour of mendel's genetic units and behaviour of chromosomes during meiosis.
 - (d) Genes are located on chromosomes and different chromosomes carry different genes.
 - (e) There may be linkage of genes on chromosomes.
 - (f) Failure of two sex chromosomes to separate during meiosis is called nondisjunction.

BSCS	Huffield	Comments
Relationship of heredity and environment is discussed by illustrations, examples of <u>Drosophila</u> , Identical twins, chlorophyllless plants. P.508.	(i) Characters of organism are influenced by heredity and environment. P.95(V).	In BSCS, mendel's law of inheritance, probability, hybrid vigor, similarities between mendel's units and chromosomes, are discussed in detail, whereas in Huffield
(1) Mendel's law of inheritance are discussed in great details including the probability in Genetics. P.514.	(ii) Inheritance and environment is discussed in details. Pp.96,97(V) Experiments illustrating on breeding of dogs.	these ideas are dealt very briefly.

BSCS	Nuffield	Comments
1) How hybrid-vigor of corn can be increased by double cross is discussed. Pp. 524-525.	How characteristics of an organism are inherited is explained by experiments done on <u>Drosophila</u> . Pp. 15, 16(V). Idea of probability is given.	In Nuffield, hybrid vigor is not discussed.
1) Details of meiosis are discussed and 2 pairs of chromosomes during segregation is compared with Mendel's pairs of traits.	This idea is not dealt.	Practical: In BSCS, to determine type of inheritance in linked genes and sex linked genes. In Nuffield, long term breeding investigations with one organism. Breeding investigations with <u>Drosophila</u> . In BSCS, meiosis, behaviour of chromosomes during meiosis, sex chromosomes are dealt in detail.
(1) Experiments on fruit fly are discussed which give evidence for chromosome theory of heredity.	Experiments on <u>Drosophila</u> are discussed which shows characters are inherited through chromosomes. Pp. 16, 17, 18(V). This is further explained by using models of beads.	
(1) Bridges's experiment is discussed. P. 540.		
1) Sex chromosomes have genes that determine sex. This is explained by taking characters like colour blindness hemophilia. Pp. 539, 540.	(1) Idea of sex chromosomes is given in teacher's guide V. P. 48.	Whereas in Nuffield, behaviour of chromosomes during meiosis is not discussed.

BSCS	Nuffield	Comments
(ii) Chromosomes which do not have genes for sex are autosomes.		Sex linked inheritance is discussed in details in BSCS and it is just mentioned in Nuffield
(i) Sex linked inheritance is explained by illustrating ^a hemophilia and color blindness as example. Pp. 530, 540.	Sex linkage of chromosomes is just mentioned in teacher's guide V. Pp. 165-166.	which is a notable omission. In Nuffield nondisjunction of chromosome is not dealt, which is very important idea and should have been discussed.
(ii) Linkage crossing over is discussed. Pp. 541, 542.	Idea of nondisjunction is not given.	
Phenomenon of nondisjunction in <u>Drosophila</u> and man and its drastic effects in human being have been discussed. P. 546.		

Topic: Genetic continuity

Subtopic: Genes and how they act

Idea: Gene is Deoxyribonucleic acid that is a part of chromosome.

- Subideas:
- (a) Genes can be extracted and transformed.
 - (b) Active principle in transferring inherited characters is deoxyribonucleic acid in all (except ^{some} viruses) organisms.
 - (c) DNA is the genetic material in animal viruses.
 - (d) In plant viruses genetic material is RNA.
 - (e) DNA is a complex molecule composed of phosphoric acid, deoxyribose, purines and pyrimidines.
 - (f) There is self duplication of DNA in all organisms.
 - (g) RNA molecule is made up of phosphoric acid, ribose, purines and pyrimidine.
 - (h) Gene controls all the activities of a cell.
 - (i) RNA and DNA plays an important role in protein synthesis.
 - (j) DNA in the form of triplets (3 bases) communicate directions for synthesis of proteins. It is known as DNA code.
 - (k) Nucleus can work only, in and with the cytoplasm.

BSCS	Huffield	Comments
1) Genes can be extracted from one organism and can be made to enter another.		In BSCS, idea that genes are DNA and part of chromosomes is brought out.

BSCS	Nuffield	Comments
<p>By transferring genes abilities are transferred. This is explained by experiments of Griffith with <u>pneumococcus</u>.</p>		<p>In BSCS Experiment of Griffith on transfer of genetic material is well presented. Nuffield has failed to bring out</p>
<p>1) Historical approach regarding DNA as active principle is dealt. P.550.</p>	<p>DNA is capable of transferring inherited characters. This is explained by experiments on bacteria.</p>	<p>these. DNA is genetic material and it transfer inherited characters, this idea is brought out nicely in both. Practical;</p>
<p>1) This subidea is explained by giving example of bacteriophage. P.551.</p>	<p>P.50(V).</p>	<p>In BSCS, to determine how characteristics governed by separate genes on different chromosomes are inherited.</p>
<p>(1)</p>		<p>In Nuffield, to study relationship between genes and chemical processes of cells.</p>
<p>1) DNA model consisting of two strands twisted about one another is illustrated.</p>	<p>Model of DNA consists of 2 chains of nucleotides wrapped round each other in a double spiral is described. P.56(V).</p>	<p>In both projects detail structure of DNA and its smaller molecule are given. In BSCS more chemistry is involved.</p>

BSCS	Nuffield	Comments
(1)Detail structure of phosphoric acid, deoxy-ribose purines and pyrimidines brought out by illustrating figures and description. P.551-555.	(11)Detailed structure of DNA and its smaller molecules are given P.86(W). (111)Amount of DNA/nucleus in sperms and RBC of animals is described. P.82(V).	In Nuffield - amount of DNA present per-nucleus (RBC and sperm) and distribution of DNA in different cells of same animal is discussed.
(1)DNA molecule replicates. (11)Two strands are separated. All events of DNA duplication are described nicely by using figures also. P.556,557.	(1)Self duplication of DNA is discussed by referring experiment on bacteria. Pp.147, 148(V). Teacher's guide.	These important and interesting points are not dealt in BSCS. Self duplication of DNA is discussed in both.
(1)Details of structure of RNA molecule is not known. Primary structure of RNA is described. P.565. (11)Messenger RNA and transfer RNA are described in short. Pp.566,567. (1)Genes do their work by their effects on enzymes.	(1)Mention of RNA is in Teacher's Guide.P.94(V). (11)Synthetic RNA and for solving of DNA code P.95(V) Teacher's Guide. (1)Genes affect chemical reactions in cells by influencing the formation of enzymes.P.87(V).	In BSCS, Structure of RNA, and tRNA, mRNA are given as part of protein synthesis. In Nuffield - RNA is just mentioned in Teacher's guide. "Genes work through their effects on enzymes". This idea has been discussed in both.

BSCS	Huffield	Comments
(ii) Gene action in <u>Neurospora</u> is discussed. Pp. 556-561.	(ii) Inheritance of sickle cell condition is discussed. P. 181(V).	In BSCS - gene action in <u>Neurospora</u> and man is discussed, whereas in Huffield - only gene action in man is discussed.
(iii) Gene action in man illustrating sickle cell anemia is discussed. P. 563.		
(i) Proteins are built of various combinations of more than 20 amino acids.	(i) Proteins are made up of amino acids of 20 different types.	Structure of protein molecule is dealt in both projects.
(ii) Proteins are synthesized inside the cells.	(ii) There is just mention of instructions given for synthesis of protein.	In BSCS protein synthesis is described in detail with illustrations, whereas Huffield has failed to bring out this idea, which is very important.
(iii) Main steps of protein synthesis are dealt very nicely using figures also. Function of TRNA, MRNA, Ribosomes and DNA during protein synthesis are described very well. Pp. 566, 567.	Pp. 96(V), 147(V). Teacher's Guide.	
(i) ^{Three} Four letters (4 bases) put together in 64 triplets are sufficient to code the 20 different amino acids.	(i) Code carried by DNA is called genetic code. (ii) It uses the bases of the nucleotides as symbols.	Genetic code has been explained in both. In BSCS, historical aspect of discovery of DNA code is also discussed, but Huffield has not done this.
(ii) Different triplets of DNA can be used to code the same amino acid.		

BSCS	Huffield	Comments
(iii) Detailed structure of DNA code is given. Pp. 568-569.	(iii) Arrangement of nucleotides along DNA molecule provides instruction. (iv) Bases are arranged in triplets. Pp. 85, 87(V).	
(i) Nucleus cannot function if it is provided only with a part of conditions and materials needed for development. This idea is explained by considering experiment on eggs of sea-urchin <u>Acetabularia</u> . Pp. 571, 572.	(i) Nucleus and cytoplasm both influence the development of organisms. This is explained by taking example of <u>Acetabularia</u> . Pp. 94, 95(V).	The idea that nucleus and cytoplasm both influence the development of organism has been discussed in both but more detailed descriptions and diagrams are given in BSCS.
(i) Genes in nucleus control the path of development only.		

Topic: Genetic ContinuitySubtopic: Genes in population

Ideas: The study of genefrequencies is the basis of population genetics.

Subideas: (a) Genes of an organism in a population make up gen pool.

(b) Some factors cause change in genefrequencies.

BSCS	Nuffield	Comments
(i) All the genes that members of a population may contribute ^{to} the next generation is the gene pool.	(i) Genes of an organism in a population make up gene pool.	Gene pool and Gene frequencies of organism are discussed in both. But Nuffield has not discussed the factors which cause change in gene frequencies.
(ii) Any off-spring represents a random sample from gene pool.	(ii) It is important to know genepool for prediction of composition of future population.	
(iii) Hardy Weinberg Principle is explained in detail. Pp. 574-578.	(iii) Gene pool is explained by using coloured beads	
(i) Mutation	(iv) Hardy Weinberg principle is discussed. P. 164(V).	
(ii) Natural selection	(i) Factors which cause change in gene frequencies is not dealt.	
(iii) Isolation		
(iv) Emigration and Immigration. All these factors are discussed in detail. Pp. 580, 581.		

Idea: 2. Man does selection of plants or animals which possess desired qualities by improving genetic lines. This is artificial selection.

Subideas: (a) Artificial selection is done by man to improve quality of his domesticated plants and animals.
(b) Improvement of genetic lines is always in the direction of increased use or value.

BSCS	Nuffield	Comments
(i) Artificial selection is explained by taking examples of American cattle, hybrid vigor in maize and wheat's dealt. P. 581.	(i) History of Shetland Sheep dog to explain artificial selection. Artificial selection in seeds, cows and maize is dealt. Pp. 188, 181(V).	In both same idea has been brought out by illustrating different examples. In Nuffield-harmful effects of artificial selection are discussed.
(i) Improvement in quality of seeds, fruits, vegetables, flowers and trees. P. 683.	(i) Producing better quality of seeds. P. 191(V).	
(ii) Artificial insemination for animals is discussed. P. 584.	(ii) Artificial insemination for improvement of animals is dealt. P. 191(V).	
	(iii) Harmful effects of artificial selection.	

Ideas: Human heredity is studied by (traits) genes that have low frequency in gene pool.

Subideas: (a) We know about human heredity from study of rare traits.

(b) Rare traits are controlled by genes that have low frequency in the gene pool.

BSCS	Huffield	Comments
1) Human heredity is discussed with reference to blood types, hemophilia, color blindness, baldness, skin colour, blindness, height, weight, etc.	(1) Human heredity is discussed with reference to sickle cell anaemia, blood groups, scientific ability etc. Pp.176,180(V) 13,14(V).	In both projects human heredity is discussed with reference to different characters.

Topic: Evolution

Ideas: The process of natural or artificial selection acting upon genetic diversity in organism is evolution.

- Subideas:
- (a) Lamarck and Darwin gave theories on evolution and on the origin of new species.
 - (b) Darwin's theory of evolution has been supported by many evidences.
 - (c) Genetic variability can originate by mutation.
 - (d) Genetic diversity can originate by recombination of different alleles.

BSCS	Huffield	Comments
(1) Darwin's theory of evolution has been discussed in detail and has been compared with Lamarck's theory. P.596.	(1) Darwin's theory of evolution has been discussed. In the book it is said that "he gave wrong name to his book it is known as 'origin of species'. In fact he confines his descriptions on what happens to species of organisms after they have originated". P.203(V).	In BSCS, both Darwin and Lamarck theories have been compared by illustrating figures. In Huffield, only Darwin's theory is given, Lamarck theory of evolution is not mentioned.
(2) Evidences from geological record, geographical distribution, inheritance and breeding, homologues and embryology have been	(1) Evidence from fossil record has been dealt. Fossil history of horse is given.	In BSCS, evidences from many fields which support Darwin's theory of evolution is dealt but in Huffield only evidence from fossils are discussed.

BSCS	Nuffield	Comments
(i) Mutations is a source of raw materials for evolution.	(i) Mutation is known to occur in every type of living organism.	Mutation is described in detail in both.
(ii) Mutations are heritable characters and mostly recessive.	(ii) New characters arise apparently and spontaneously in organisms by mutation.	In Nuffield, importance of recombination of genes is not mentioned.
(iii) Mutations occur rarely and mostly harmful in nature.	(iii) Mutations occur randomly. P.60(V).	
(iv) Rates and effects of gene mutation are discussed. Work of Muller has been described. P.611.	(iv) Role of genes in mutation is discussed. P.64(V).	
(v) Effect of radiation on organisms is mentioned.	(v) Effects of radiation on plants and organism is dealt in detail. Pp.88,89(V).	
(i) Recombination of individually "bad" genes to yield better organisms is discussed. P.615.	(i) Chromosome rearrangement and chromosome multiplication results in mutation. P.60(V).	
(ii) Sexual reproduction and recombination is dealt in detail. Pp.617-618.	(ii) Some examples of mutation are given.	
(iii) Importance of recombination has been mentioned. Pp.218,219.	P.64(V).	

Topic: EvolutionSubtopic: Evolution of ManIdeas: There is genetic evolution of man.Subideas: (a) Genetic evolution of man is the result of continuing action of mutation, recombination natural selection and isolation.

BSCS	Nuffield	Comments
(i) Man appeared 10,00,000 years ago in recent pleistocene. P.662.	(i) Human beings possess inherited characteristics.	In BSCS, the genetic evolution of man has been discussed ^{considering} fellow-
(ii) First animal to which name man was assigned was pithecanthropus.	(ii) There is natural selection in man.	ing various stages
(iii) Different stages which have occurred during evolution of man are discussed in detail. Pp.662,665.	(iii) By study of fossils we know that over 25 thousands years, human body has changed very little. P.204(V).	which has led to the modern man. In Nuffield, the different stages leading to the modern man are not discussed.

Ideas: 2. There has been cultural evolution of man.

Subideas: (a) In cultural evolution much of human behaviour is transmitted not by the genes but by writing or the spoken word from one generation to the other.

(b) ~~History of animals and plants during past 600 million years is known to us.~~

BSCS	Huffield	Comments
(i) Cultural evolution determines human behaviour and it has substituted cultural inheritance for physical heredity via the genes.	(i) Human behaviour is passed from generation to generation by cultural evolution.	Cultural evolution has been discussed properly in both with reference to the civilization of man. In Huffield
(ii) It is independent of physical changes in his body.	(ii) Interaction of ideas and ways of life cause human society to change.	idea of geographic origin of domestic plants and animals is not brought out. It is
(iii) Origin of cultivated plants and domestic animals by artificial selection; geographic origins of important domestic plants and animals; agriculture and civilization are discussed in detail. Pp. 674-684.	(iii) Man has capacity to alter his environment and thus the influence of natural selection is modified. Pp. 205, 206(V).	very necessary to know about plants and animals which we are using in our daily life.

Topic: Origin of Life

Ideas: Origin of life on this Earth is controversial.

Subideas: (a) Living things can arise from living things only
and not from nonliving things.

(b) How the first living things arose is also a
matter of dispute and scientists are trying
to solve it.

BSCS	Nuffield	Comments
i) Life does not arise spontaneously.	(i) Organisms arise spontaneously from non-living matter was a belief in the past.	In both, the same idea that life cannot arise spontaneously is discussed.
ii) Living things could always have existed on this earth.	Experiment of Pasteur to prove that life can not arise spontaneously	
iii) Life has originated on earth at some remote time in the past. Pp. 633, 634.	(ii) Evidences show that organisms arise from other living things by reproduction.	
Experiment of Pasteur is given which demonstrates that life cannot arise spontaneously.	(i) Experiment of Miller regarding the origin of life is not dealt.	In BSCS Experiments of Miller, Melvin and Calvin on "origin of life" are discussed very nicely. Nuffield has failed to bring out these ideas which are very important and interesting.
i) Experiment of Miller is given which concludes that amino acids can be synthesized from Methane, ammonia water vapour when electric charge is given. Amino acids are structural unit of proteins and proteins are building blocks of life.		

BSCS	Nuffield	Comments
(iv) In the beginning earth atmosphere must have contained methane, nitrogen, oxygen, hydrogen and water vapour. Due to the very high temperature these may have combined to form amino acids. This is first step of origin of life. Pp.635,636.	Not dealt at all.	
(v) Experiment of Melvin and Calvin is described which shows that artificially purines and pyrimidines can be synthesised. These are important compounds in life processes and heredity of living organisms.	There is no mention about this experiment.	
(vi) There is no direct or indirect evidence that earliest living things were associations of organic molecules.		
(i) Geological time scale, with notes of events in the evolution of life and environment is discussed. P.361.	This idea is not discussed.	Geological time scale and life in geological eras has been dealt in BSCS. In Nuffield this important and interesting part is not discussed.
(ii) Life in paleozoic, Mesozoic and cenozoic eras is discussed in detail. Pp.640-652.		

Topic: Ecology

Subtopic: Habitat

Idea: Locality in which a plant or animal lives is its habitat.

Subideas: (a) Habitats are populated by organisms.

(b) Habitat is a testimonial to the genetic variability and natural selection.

BSCS	Huffield	Comments
<p>(i) Major types of habitat in the world such as oceans, grasslands forest and deserts are described in details using figures. p.692.</p>	<p>(i) In order to become established in a habitat an organism must obtain 3 things from it.</p> <p>(a) supply of right kind of food.</p> <p>(b) shelter</p> <p>(c) some place to breed.</p> <p>(ii) Competition is a feature in the process of becoming established.</p> <p>(iii) Organism can only be regarded as established if it breeds successfully. Pp.28-33(V).</p>	<p>This idea is dealt briefly in both projects.</p> <p>Practical:-</p> <p>In Huffield, experiments are organised to study habitats. Experiment to study competition for food between animals and competition between plants.</p>

Subtopic: Ecosystem

Ideas: Animals and plants as they exist in nature are parts of an ecosystem.

- Subideas:
- (a) Ecosystem is a dynamic concept.
 - (b) It deals with how individual organism interact with one another and with their nonliving environment.
 - (c) Predators, prey, producers, decomposers, energy source and matter are involved in ecosystem and it forms a food chain.

BSCS	Huffield	Comments
<p>(i) Ecosystem is dealt in detail. Ecosystem can be a lake, pond, pool, ocean or aquarium. Ecosystem in sea is described.</p> <p>(i) Food webs, fossil food webs have been discussed. p.173,174.</p> <p>(ii) Interactions of organisms with each other and with the environment are discussed. Pp.689,690.</p> <p>(i) Role of producers, decomposers, primary and secondary consumers in ecosystem is discussed. p.171,696.</p>	<p>(i) The word Ecosystem is not used and not discussed.</p> <p>Food webs and food chains are discussed in quite detail and nicely. Role of producers, consumers, decomposers has been brought out. Pp.65(III), 847(IV).</p>	<p>In BSCS, ecosystem is discussed, along with its food webs and food chains are discussed.</p> <p>In Huffield, the term ecosystem is not at all mentioned. Only food webs and food chains are discussed.</p> <p>No practicals in both.</p>

BSCS	Huffield	Comments
<p>(iii)Pyramid by living matter is discussed showing progressively fewer nubers of individuals in each category. P.173.</p>	<p>(iii)The quantitative relationship between populations is represented by a pyramid of numbers, from numerous herbivores at the base to few predators at the apex. P.250(IV).</p>	<p>The presentation is more or less similar in both.</p>

Subtopic: Succession

Idea: Process involving changes in population is called succession.

Subidea: (a) Succession involves changes in number and varieties of individuals within a community.

BSCS	Huffield	Comments
i) In community, there can be replacements or additions.	(i) Pioneers colonise open place new arrivals come	How colonization and ends in climax
ii) Living things spread some kinds of life prove to be more efficient than others and quickly occupy an area.	and form closed community. (ii) Competition for food light and space takes place between pioneer species and newly arrived	community is discussed in both. In Huffield role of human beings in succession is discussed.
iii) Others follow pioneers and crowd them out. Competition for food and light takes place. Thus some species survive. Pp.172,173.	species so some kinds of organisms are replaced by others. (iii) How succession ends in a climax community is discussed.	In BSCS, observation of different stages in plant and animal succession in different communities.
iv) How succession, leads to climax community is discussed. P.174.	(iv) In what ways human beings bring changes in early stages of colonization is also discussed. Pp.25,26(IV)58,59(IV) 252(IV).	Huffield: Study of food chain. Observation of succession in water- trough, pools and some investigations.

Subtopic: Distribution of organisms

Ideas: Each organism requires particular set of conditions which determine its distribution.

Subideas: Plants and animals are unevenly distributed.

BSCS	Huffield	Comments
Distribution is not dealt with in BSCS.	Various Physical conditions which affect distribution of organisms, are discussed. The ⁱⁿ fluence of interdependence of conditions is described. PP.173-183.(III).	Practical, experiments to study physical conditions and distribution of organisms.

Ideas: 2. The process of reaching a habitat is called dispersal.

Subideas: (a) organisms can be dispersed by

- (i) producing vast number of potential youngs.
- (ii) developing structures whose form is suited for distribution by agents.
- (iii) compromise between these two.

(b) (i) Quantity of seeds and its relation to dispersion is discussed. Pp.202-204(III).

(ii) Adaptation in plant parts for dispersion by air is described. P.198(III).

(iii) Adaptation in seeds or fruits for dispersion by animals and by water is discussed.

Subideag: (iii) compromise between these two.

ESCS	Nuffield	Comments
	(v)Species of plants can go from one place to another by movements of flagella.P.205(III)	Practical: In Nuffield, study of dispersal of organism by water. Demonstrations which include dispersal of a species by different means.

Sub Topic: Water balance in Organisms

Subideas: (1) There is relationship between environment of land organisms and their ability to maintain water content of body.

(2) The properties of membrane and other forces work in maintaining water balance of an organism.

BSCS	Nuffield	Comments
<p>this topic is brought out by means of a practical lesson.</p> <p>(V) * selective permeability of membranes, osmosis, plasmolysis, plasma membranes in animal and plants is discussed. Pp.63-72(IV).</p>	<p>(i) Some organisms have little control of water.</p> <p>(ii) Water balance is a factor which decides distribution of particular organism.</p> <p>(iii) Leaves of plants lose water rapidly in dry condition.</p> <p>(iv) Some organisms are discussed in which water loss is beneficial. Pp.156-168(III).</p> <p>(V) *</p>	<p>It is dealt in Nuffield but in BSCS it is dealt in practical only.</p> <p>Practical; In Nuffield, to study plasmolysis demonstration which include study of osmosis.</p>

Topic: Ecology

Ideas: Sometimes bodies of living organisms

(plants & animals) provide habitats for other living things.

Subideas: (a) Relationships and situations vary.

(b) Organisms colonize outer or inner surface.

(c) Organisms are used to reduce number of pests - predators.

BSCS	Nuffield	Comments
These ideas are not discussed.	<p>(i) Epiphytes and epizoites have loose association with host. Saprophytes and Suprozoites take nutrition from host which is not used by host. Parasites are also described. P.278(IV).</p> <p>(ii) Organisms colonizing others are abundance and widely distributed.</p> <p>(iii) Organisms living internally are more protected and get constant supply of food.</p> <p>(iv) Offsprings are produced in large numbers but dispersal to new hosts is difficult.</p> <p>(v) Organism has to be selective & should confine attention wholly to the pest. Pp.267-277(IV).</p>	<p>Idea of relationship between living organisms is not discussed at all in BSCS.</p> <p>In Nuffield these ideas are discussed nicely and should be dealt in BSCS also.</p> <p>Practical: In Nuffield observation of parasites and epiphytes.</p>

Topic: Classifying Living ThingsIdeas: Living things can be identified by using a keySubideas: (a) All keys are artificial.

(b) Keys use features which are clearly identifiable.

(c) Correct use of key requires close observation
of a specimen.

(d) A key can be designed for any number of species.

BSCS	Nuffield	Comments
simple key to flowering plants is given in students laboratory guide.Pp.133-134. key for animal classification is given in student laboratory guide. Pp.174-176.	(i)Key for identification of tree leaves is given. (ii)Key for identification of seeds has been discussed,the knowledge to (iii)Key to 6 breeds of dog has been discussed. Pp.53,55(I).	Practical; In Nuffield making a key and applying the knowledge to new situations, studying variation in living things.

Topic: Homeostasis

Ideas: The maintenance of internal steady states is homeostasis.

Subideas: (a) In living organisms internal stability is a factor contributing to survival.
It is state of constancy.

BSCS	Nuffield	Comments
(i) Preservation of life in face of change.	(i) Environmental factors determine whether a body shall gain or lose heat, thus alter its temperature.	Idea of homeostasis is presented in both by giving different examples.
(ii) Homeostasis in paramecium in connection with control of water is discussed.	Use of thermocouples to measure temperature of skin is discussed.	Practical: In BSCS, water control in <u>paramecium</u> . In Nuffield
(iii) Coordination for more homeostatic control is discussed.	(ii) The maintenance of oxygen supplies to tissue is by feed back.	to investigate temperature fluctuation of one hand with forced temperature
Pp. 351, 6, 428, 448.	Mechanisms are discussed by which steady state conditions are maintained.	fluctuations of the other hand.
	Pp. 204, 205.	

DISCUSSION

The salient features of the BSCS and the Nuffield project materials that came to light as a result of the comparative studies made here, are discussed below with reference to their structure, presentation, content and specialities vis-a-vis their adaptability or applicability in India.

In USA, General Science is taught as an integrated subject at middle stage. Biology is taught as a separate discipline at the 10th grade. Five periods per week are allotted for Biology. The BSCS materials for the high school Biology is an integrated course for one year. Thus BSCS texts (yellow, blue and green version) are for one year and designed to meet the needs of plus fourteen age group.

In U.K. the system of education is entirely different. Here the specialization starts at very early stage. Science is taught as separate disciplines from 1st form which is equivalent to our 6th class. The age of pupil at this stage is 11. Biology is treated as one of the disciplines and biology course runs from 1st form to 5th form i.e. for 5 years (11 to 16). Thus the Nuffield Biology Programme is based on this structure. The course falls into 2 parts; the first two years which can be regarded as introductory and the remaining three which constitute the intermediate phase. It has produced a series of pupil's texts one for each of the 5 years of an O-level course which are closely backed with teacher's guides.

In India science is taught as an integrated course of General Science in classes V, VI, VII, VIII, IX & X. Biology is taught as an elective subject at higher secondary level and the course runs for 3 years (IX, X & XI).

But now the provision has been made to teach science as separate disciplines of Biology, Physics and Chemistry at the middle stage (project of the National Council of Educational Research and Training) carried out in collaboration with the UNESCO, for improvement of Science and Mathematics education at middle school stage). Taking this point into consideration, we can say that our new educational pattern in science resembles in a way to the O-level course of U.K. Thus that the O-level Nuffield Biology course can be taken as a model to be adapted to Indian conditions as far as pattern of education and age group is concerned. We can have a biology course running from classes VI to X.

Presentation

In BSCS, Primary emphasis has been laid upon science as investigation and enquiry. Observation, experiment, hypothesis and verification are four important bases for this structure. Enquiry and investigation are means of acquiring significant knowledge in science. They have named the yellow version as "Biological Science: An enquiry into life". It is clear from this also that their main emphasis is on enquiry. Their idea is that "one of the best way for a student to understand the science is to act like a scientist. Therefore, student should play an active role in conducting experiments and in performing the scientist's role as far as possible."

They have prepared a laboratory centered programme of instruction that makes use of the textbook only as a supplement to learning. As it is mentioned (in introduction to the Teacher's manual for student Laboratory Guide Page XI)" it is not necessary

however, to read the textbook before undertaking related laboratory work. Many times it is advantageous and necessary to do the laboratory work before reading textbook chapters".

In each of the texts, at the end of each chapter the student is faced with a number of guide questions which are mostly of the enquiry type. These questions are listed roughly in the order of increasing difficulty. Answer to these questions are frequently given in the text.

Textbook is associated with a teacher's manual, teacher's manual for student laboratory guide and student's guide. Most of the laboratory experiments are of enquiry type. Student has already built up an understanding of the basic concepts. He acts like a scientist and applies his knowledge and understanding to solve problems. The laboratory guide helps the student to know what should be seen.

Each exercise begins with a short introduction and a list of materials to be used. The procedure is given which is followed by a number of questions which lead to a series of investigation of major concepts and principles. By performing experiments, observing, making hypothesis, detecting, critical thinking and by deductive reasoning the student is able to answer these questions.

This can be seen by illustrating an example.

Exercise 3-5(Page 21)

"Living Plant Cells with Chloroplasts"

Introduction - Student is introduced to the idea that green plants make food in presence of light. Purpose of this exercise is to look inside cells of Elodea to discover where chlorophyll is located.

Procedure - Take one plant and break off one younger leaf.

Place it in a drop of water on a clean slide and put on a cover glass. When you see it under low power you will see that some cells seem to be packed with small green bodies. These are called chloroplasts.

- (1) What is the difference in function between cells that contain chloroplasts and those that do not contain chloroplasts?
- (2) What is the shape of a single chloroplast?
- (3) Where in the cell are chloroplasts located?
- (4) How can you account for movement of chloroplast?

The Nuffield Biology course is designed to foster a critical approach to the subject with more emphasis on experimentation and enquiry. The student is being faced with a series of problems, he does practical experiment and on the basis of the results he builds the basic concepts and understanding.

The first hand information is derived from the laboratory and second hand information is obtained from books and film loops. Thus the child tries to understand principles of Biology by himself.

This can be visualized by illustrating some examples.

Chapter 8 (II) "How plants reproduce and make seeds"

- (1) Finding different parts of a flower.
- (2) Examining the bud of a flower.
- (3) Examining pollen and its kinds.
- (4) Watching insects visiting flowers.
- (5) Growing pollen grains.
- (6) What happens if the pollen is not allowed to reach stigmas.
- (7) What will happen if pollen from same flower or another flower is brought to stigma.

(8) How fruit is formed and seeds are shed.

Thus a student is being faced with a series of experiments and he has to observe each and every thing very critically. On the basis of results and deductions he will build some basic concepts regarding the reproduction in plants.

Throughout the text numerous opportunities are provided for initiating simple investigations.

Special Features.

In ESCS textbook and teacher's manual at the end of each chapter suggestions for additional reading is given which includes the books, magazines and journals, ~~whereas in Nuffield it is not so.~~ In Nuffield texts, at the end of most chapters, a short section entitled 'Background reading' is given. The topics covered in this relate to the preceding chapter in a variety of ways and are usually extensions of particular subjects which have not been possible to develop fully elsewhere. These constitute very interesting reading material for both the student and the teacher.

In ESCS each text is associated with a teacher's manual, student's laboratory guide and teacher's manual' for students laboratory guide. But in Nuffield the whole text book itself is experiment oriented. Practice and theory occur side by side and practicals are inter-woven with the students texts. Thus there is no need for a separate student's laboratory guide. In the textbook itself instructions, procedures and list of materials are given.

In the Nuffield course more or less equal emphasis is given to class practical work and demonstrations. For example, in the chapter "Respiration obtaining energy", four class practicals

are proposed to be done by students and there are four demonstrations, which are to be shown by teachers (chapter-3, P.42 Teacher's guide III).

Preparation and homework constitutes an integrated part of Nuffield Biology course. A certain amount of time out of school is devoted for writing practical work which is kept to a minimum. In the text, numerous questions are posed under each topic and frequently answers of these questions are not given. These provide useful material for homework. At the end of most chapters "Background reading" is included which also provides an additional reading out of school hours.

The discussion plays a very important role in the Nuffield Biology course. Discussion provides an excellent opportunity for enables students to make investigations for revision. It/themselves through mutual exchange of ideas under the guidance of the teachers.

Aspects which are omitted from Nuffield Biology Project materials

1. Resemblances and differences of animal and plant cell.
2. Electron microscopic structure of a cell.
3. Variation in size and shape of cells.
4. Viruses.
5. Different systems of animal life.
6. Geological time scale and life in different eras.
7. Protein synthesis.

Differences and resemblances of animal and plant cell is not brought out in Nuffield. But in BSCS, this idea has been brought out with the aid of diagrammatic sketches which explains this very clearly to pupils. In our texts this idea is presented by making tabular columns and writing animal cell characters on

one side and plant cell characters on the other. If resemblances and differences are brought out in figure (as it is done in BSCS) it will be better appreciated by students. They can make chart representing this idea by themselves. The importance of the idea lies in the fact that it gives an opportunity for the student to know that although cell is the basic unit of living things, there are yet some fundamental differences between plants and animals which are reflected even in the structure of the cell.

Electron microscopic structure of a cell is not dealt with in Nuffield, which is similar to Indian syllabus also. Cell is the basic unit of life, therefore a student of Biology should know as much of it as possible. Electron microscope reveals many structures such as endoplasmic reticulum, ribosomes, porous cell membrane etc. which were not known to us previously. This idea is very simple and can be given to students with the help of electron microscope photograph and suitable diagrammatic sketches as given in BSCS. Unless this is told, the student will not be able to connect the structure of the cell with the cellular functions which he will be learning at a later stage.

Variation in shape and size of cells is not very important. Student will be aware of shape and size of cells, when he observes and studies the different organisms. In Indian texts, lengthy descriptions are given regarding this idea which is quite traditional and should be omitted.

Viruses, which form the threshold of life, are not discussed in detail in Nuffield. Historical discoveries which led to the the isolation of viruses are very interesting and should be presented to the student of Biology. At the present time, viruses

constitute a major field of study in Biology and many interesting and important scientific investigations are being carried on in this field. By studying viruses the problem of origin of life can be solved to some extent. 'virus' can be included in the microorganisms and its detailed structure can be presented in a very simple way as given in BSCS.

Different systems of animal life is not discussed in Nuffield. Mostly all processes of man are discussed in detail. Different systems in man are much complicated than in other animals. Therefore, it is necessary that first the knowledge regarding different systems in other animals (some lower and some higher) should be given to students in brief. This will form a sort of base and will help the student to understand the complicated systems of human body.

In the Indian syllabus, the study of human body is completely omitted. Thus the student remains completely ignorant of the functioning of his own body though he becomes familiar with the life-cycle of a mosquito, the smallest bone of a frog, blood vascular system of earth-worm and coordination in Cockroach etc. Therefore it is necessary that different systems in other animals should be taught in brief and all systems in man should be taught in quite detail as Nuffield and BSCS have done. In practicals, it is not important just to see the organs involved in various processes, but what is more important is the process i.e. how they function. For example in digestive system, we should give more emphasis on how the process of digestion takes place i.e. how starch is converted into sugars; how chymes act on different food stuffs etc. 'Protein synthesis' is omitted in Nuffield which is a very notable lacuna in it. As we know proteins are responsible for most of the vital activities of the living organism and much of the recent researches has been directed in understanding biosynthesis of proteins, ^{it} is necessary for

the present day student to know how it is synthesized in the cell and the role of DNA and RNA in this context. This idea can be presented ^{by} the aid of diagrammatic sketches and brief description as presented in BSCS text.

Aspects omitted from the BSCS text.

1. Distribution of organisms (specially dispersal of seeds and fruits.
2. Interdependence of organisms.

In BSCS, distribution of organisms especially dispersal of seeds and fruits is not dealt. It is considered as dead wood. Actually this topic is quite interesting and important in the field of ecology. This deals with, how the organism reach from one place to other; what are the different agencies which play important role in dispersal of seeds and fruits and why structure of fruits and seeds vary with different habitats. In Indian texts, this topic forms an important part and is dealt in great detail which is also not very desirable. This can be dealt in brief, as a topic in ecology as it is done in Haffield.

Interdependence of plant and animals not discussed in BSCS. As we know the plants are the important source of food for animals and are purifiers of the atmosphere, animals act as agents for pollination and seed dispersal. There are some cases in which plant and animal make a close association and help each other. There can be dependence of one plant on another or one animal on another in the form of parasite, saprophyte, saprozoites, epiphytes, epixozites, symbionts etc. This is an important aspect of plant ecology and should be treated as a separate topic under this section.

Aspects which are dealt in detail in one and not in the other.

1. Activities which go on in the cells, are not dealt in detail in Haffield,
2. Names of different stages of cell-division are not given

Details of cell division are not given in Nuffield.

3. Sexual reproduction and cell structure in Bacteria are not dealt properly in Nuffield.
4. Photosynthesis is dealt in great detail in BSCS, but not in Nuffield.
5. Mendel's law and chromosome theory of heredity is given briefly in Nuffield.
6. Structure of RNA and duplication of DNA is dealt very briefly in Nuffield.

The cell is the powerhouse, performing all metabolic and catabolic activities as it is discussed in BSCS. In Nuffield some ideas are given but not at one place. There should be one chapter in texts, in which activities of cell should be discussed. In this some idea of enzymes, enzyme activity, coenzymes, energy for cell etc. Should be discussed in a very simple way and briefly as presented in BSCS. In practicals we can use enzyme such as papain which is easily available at low cost.

Idea regarding cell division is brought out in both projects, but in BSCS names of different stages of mitosis or meiosis are not given (as prophase, metaphase, anaphase or telophase). In our texts more emphasis is given to names rather than chromosome behaviour and changes in the cell which results in haploid or diploid cell. Names by themselves are not as important as the changes, combination recombination of genetic material which occur during the division in the cell. In practicals, the study of mitosis and meiosis can be of an investigatory type as it is in Nuffield instead of just observing the different stages.

Sexual reproduction and cell structure of bacteria, are not dealt properly in Nuffield. Sexual reproduction^a bacteria is a new concept and is very interesting. By studying the bacterial cell structure, we can solve some problems regarding the diseases caused by bacteria. Therefore these concepts should be presented to the pupils.

Photosynthesis is dealt in both projects but in greater detail in BSCS, though the approach is more or less same in both. In Indian texts also usually there is one chapter on photosynthesis. But in our texts factors influencing photosynthesis, procedures used for measuring rate of photosynthesis etc. are discussed at length and no attention is given to the structure of chloroplast, light energy absorbed by chlorophyll, light and dark reactions etc. These are the key concepts of photosynthesis and should be discussed as in Nuffield. At this stage there is no need to go into details of the Chemistry of Photosynthesis. In practicals we can adapt experiments as described in BSCS which require very simple materials which may be available in our schools. e.g. (BSCS Lab. Guide for students P.No. 115, 117).

Mendel's law and chromosome theory of heredity is discussed only briefly in Nuffield. Although these are fundamental and important concepts in heredity, it is surprising that the Nuffield project has not discussed it to the desirable depth.

Again the structure of DNA and duplication of DNA are dealt briefly in Nuffield. DNA and RNA form the core of life. By duplication of DNA only, each cell of an organism gets the replicated set of genes responsible for the expression of specific characters. In the same way RNA plays very important role in protein synthesis. Therefore, it is necessary that these concepts should be presented to the

students so that they may be up-to-date in their knowledge of Biology. These concepts can be presented by diagrammatic sketches and brief descriptions as they are presented in BSCS.

Aspects which are not dealt in both projects

- 1) Description of life-cycles of different plant groups.
- 2) Details of anatomy of root and stem of Dicots and monocots. Secondary growth in stem and root.
- 3) Modifications of root and stem.
- 4) Families of Angiosperms.
- 5) Biology in the service of man.

In both the projects, description regarding the life-cycles of different plant groups is not given. But in our syllabus this topic is dealt in detail illustrating some examples from each group. For building the concepts of alternation of generation, sporophyte, gametophyte etc., it is necessary to study life-cycles of at least one plant of each group. Thus the Nuffield and the BSCS materials are deficient in this.

Detailed anatomy of stem and root is not discussed in both projects. The resemblances, differences in anatomy of root and stem of dicots and monocots are not brought out. Secondary growth is also not discussed in detail. On the other hand in Indian texts these points are discussed in detail. It is very necessary to give idea of secondary growth in stem and root. Then only student will know about growth in width, formation of wood, formation of cork etc. This topic forms an important part of practicals in India.

Students are trained to become expert in cutting good sections and thus valuable time is wasted in this type of drilling work. Therefore, this topic should be reduced.

Modifications of root and stem is not described in both projects and is considered to be absolute deadwood. But this is not true. Most of the modified roots and stems such as radish, beet, potato, ginger, etc. are used in our daily life. If a student of Biology is eating 'potato' he should know that it is the underground modification of stem. Student should know, how the new plant grows by sowing a potato or a piece of zinger or a part of mint plant. To become familiar with these points, he has to know the modifications of stem.

BSCS and Nuffield have not brought out ideas such as dicots, Monocots and their families which is the reverse of the Indian syllabus. In practicals we devote most of our time in describing plants belonging to different families. Mostly the students memorise the floral formula, floral diagram, structure of fruit, leaf, flower etc. When a plant is given to them for identification, then without studying and observing different parts they write what they have memorised. This is true even in higher classes. Thus concepts and ideas are not clear to pupils. Family description; identification of leaves, roots, stem and fruit and study of inflorescence should be kept to minimum. But it is necessary to teach some families in brief, so that pupils have some knowledge of plants yielding cereals, vegetables, edible fruits, spices etc.

BSCS text and Nuffield texts are oriented in such a way that most of it deals with the Biology in relation to man. But there is no topic as 'Biology in the service of man'. There should be a separate chapter which deals with the food production, clothing, furniture, and fuel, medicine, eugenics and the unity of biology with other sciences etc. The student will also be able to appreciate the relationship between the fundamental and applied aspects of Biology. Fundamentals are important, but what is more important is how these can be applied for the welfare of humanity.

It is clear from the foregoing that a complete adaptation of either BSCS or Nuffield materials will not provide us with the balanced curriculum suitable to our conditions. However, these two materials offer a great variety of ideas from which we can be benefited. The content and presentation in yellow version is so purposeful, though simple, that it offers itself as a fine example to be followed to present even the most complicated concepts in modern Biology such as the biosynthesis of proteins; the mode of transfer of heredity and structure of macromolecules. The Nuffield Biology texts on the other hand present the lesson in an experiment oriented manner which is quite interesting and can be easily followed in our text books. This obviates the need for separate laboratory manual for students as well as for teachers. However, the Nuffield project has divided the whole curriculum into 5 interrelated compartments. Obviously such a division is not suitable to conditions existing in our country, which, include a sizable number

of 'dropouts' at the end of middle school.

Another difficulty in the adaptation of Nuffield Biology project materials is in the field of equipments and apparatus. Since the conduct of their experiments require highly sophisticated apparatus which are neither available in India nor can be manufactured nor can be imported. Hence it is easier to follow the pattern of experiments suggested by BSCS (yellow version) which make use of very simple apparatus, almost all of which are available in India.

Finally if the Biology Curriculum in India is reoriented on modern lines the teachers both the present and the future ones - will have to be trained periodically and intensively so as to enable them to carry out their duty without deficiency.

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